Part 3
Example for the Healthcare sector

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With invaluable help from Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Healthcare

Everybody want to have good healthcare, there is both a personal and social dimension

It is a prioritized political question, often tops the list in Sweden.

It impacts all of us soon or later, we need to consider:

- **ESG** Environment – Social - Governance
- Scopes
  - 1 Emissions onsite
  - 2 Emissions from purchased Energy
  - 3 The rest

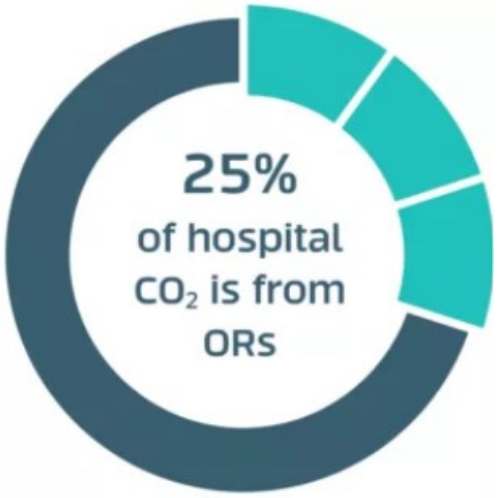
Most important political questions for Swedish voters in November 2025

https://novus.se/valjarforstaelse-arkiv/2025-11-viktigaste-politiska-fragan/

Environment Social Economics

The healthcare sector carbon emission arise from a variety of activities such as - supply chain, energy usage in buildings, transportation and medical waste disposal.

World economic forum forecasts if left unchecked, the sectors carbon footprint could triple by 2050 !!!

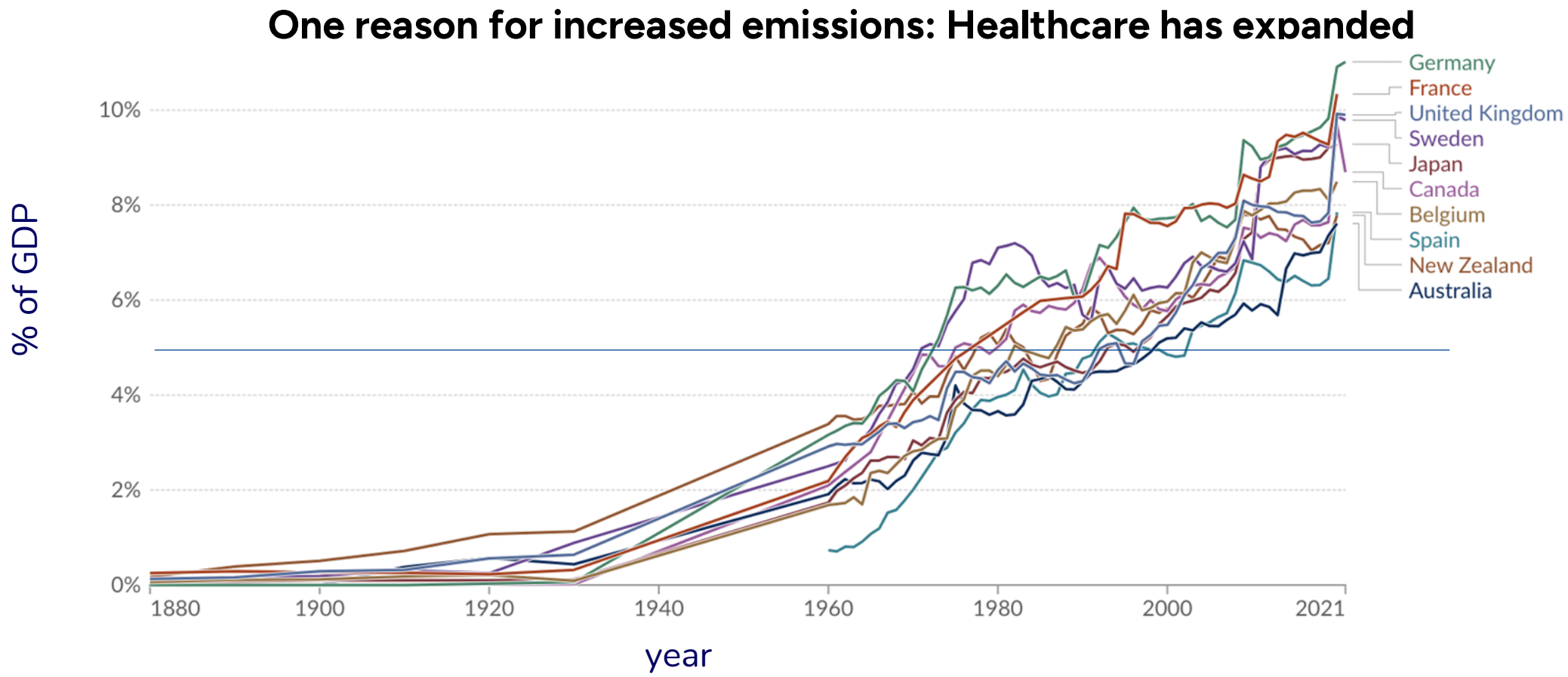


The operating rooms, although a small part of the hospital's physical footprint, contribute significantly to the total amount of waste generated in the hospital.

Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Increase of healthcare (% of GDP)

Our World in Data



Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Healthcare's role in climate change

- **Scope 1:**
  - Transport
  - Medical gases incl N_2O, fluorinated gases (high greenhouse potential)
- **Scope 2:**
  - electricity use (highly dependent on location)
- **Scope 3**: (50-75%)
  - Medical equipment, travel, catering, infrastructure, etc.
  - **Largest contributors: pharmaceuticals and disposable/consumable items**

Rodríguez-Jiménez, L. *et al.* (2023) 'The carbon footprint of healthcare settings: A systematic review', *Journal of Advanced Nursing*, 79(8), pp. 2830–2844.

Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

According to an article “Confronting Health care’s Carbon footprint” - published by Harvard Medical School.

The Global healthcare sector bleaches out between 4.4 - 5.2 percent of the world’s greenhouse gas emission.

Topography: Sweden’s health care climate footprint

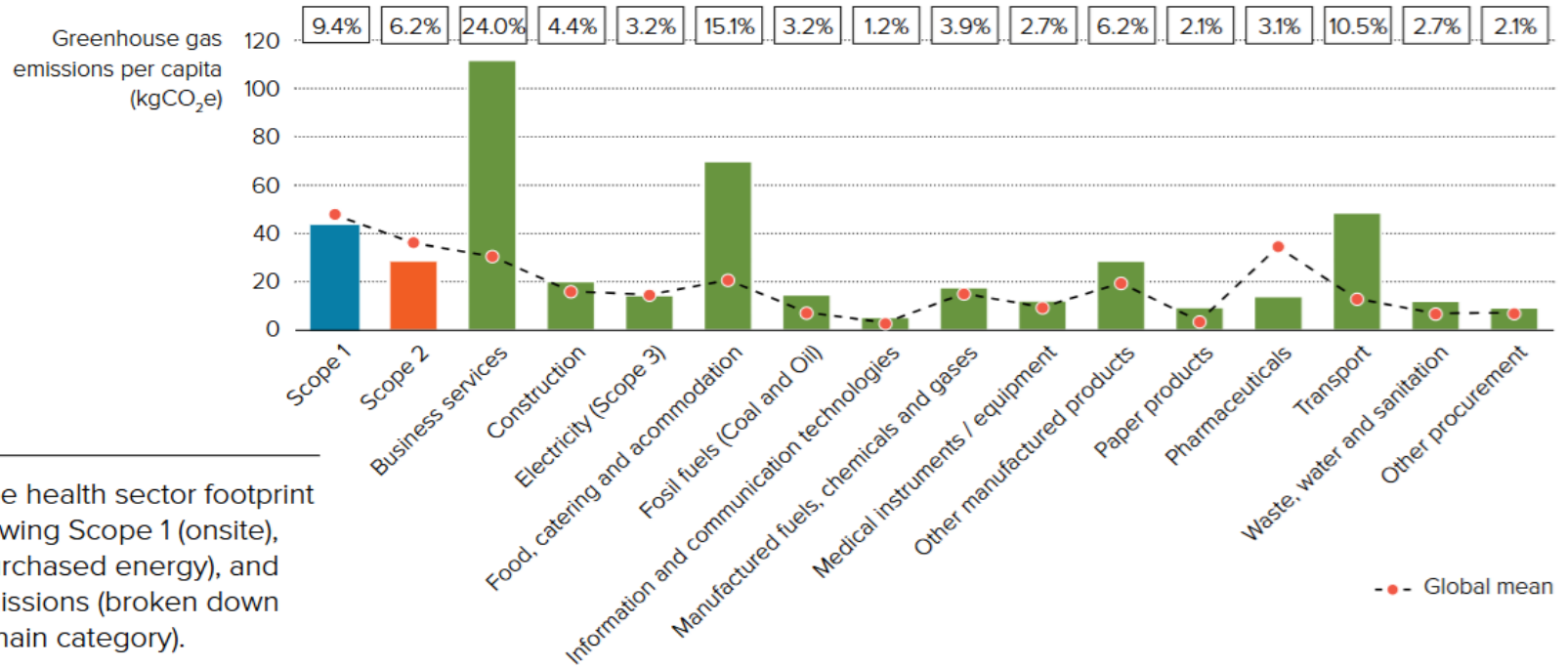


Figure 1. The health sector footprint in 2014, showing Scope 1 (onsite), Scope 2 (purchased energy), and Scope 3 emissions (broken down by supply-chain category).

Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Making Changes, Planning for more

Awareness & Quantification

1. Hospital and department teams are estimating emissions to trash audits.

2. Physicians pushing for low carbon alternatives, Telemedicine and virtual professional meetings.

3. Statisticians are breaking down emissions within healthcare - supply chain, pharmaceuticals, ambulances, employee travel, energy used in buildings, anaesthesia - to better understand what needs tackling.

Creation and assessment of Mitigation strategies

Organizations draft plan to achieve net zero carbon emission by 2050.

Significant change from Bottom-up

So-called easy wins include reducing greenhouse gases in anesthesia and inhalers and identifying where disposable materials can be replaced with recyclable or reusable ones. Some labs are experimenting with slightly raising sub zero freezer temperatures to save energy without damaging biological samples

Courtasy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Reducing Scope 3 emissions

Scope 3
Upstream

Approx. 75%
of total emissions

Benefits of the 80-20 Strategy

Prioritise efforts
Focus on the 20% of suppliers contributing to 80% of emissions for maximum impact.

Drive supplier engagement
Foster collaboration and active participation from key suppliers to drive emissions reduction.

Build transparency
Gain visibility into the emissions hotspots across the supply chain for targeted interventions.

Reduce overall emissions
Concentrate efforts on high-impact areas to achieve significant reductions in overall emissions.

Source: ING

Carbon footprint of different types of paracetamol

Type of paracetamol	CO2 emissions (in grams)	Cost (in Euros)	Waste (in grams)
Paracetamol 1 gram (oral)	36	0.07	5
Paracetamol 1 gram (rectal)	12	0.57	10.5
Paracetamol 1 gram (intravenous)	346	1.89	146

Source: Erasmus MC

Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Role of pharmaceuticals in climate change

- Sources of emissions:
  - Transport and distribution
  - Agriculture for raw materials:
    - Land-use changes
    - CH_4 release from livestock whose products are used in pharmaceuticals (eg gelatin)[1]
  - Manufacturing processes
- Carbon footprint of pharmaceutical manufacturing is significant:
  - In 2018, emissions from pharmaceuticals was higher than automotive manufacturing (52 million vs 46 million CO_2e)[2]
  - In the USA, ~1% of national GHG emissions are from pharmaceutical manufacturing[3]

1. Lenzen, M. et al. (2020) 'The environmental footprint of Health Care: A Global Assessment', The Lancet Planetary Health, 4(7).
2. Weaver, E., O'Hagan, C. and Lamprou, D.A. (2022) 'The sustainability of emerging technologies for use in pharmaceutical manufacturing', Expert Opinion on Drug Delivery, 19(7), pp. 861–872.
3. Parvatker, A.G. et al. (2019) 'Cradle-to-gate greenhouse gas emissions for twenty anesthetic active pharmaceutical ingredients based on process scale-up and process design calculations', ACS Sustainable Chemistry & Engineering, 7(7), pp. 6580–6591.

Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

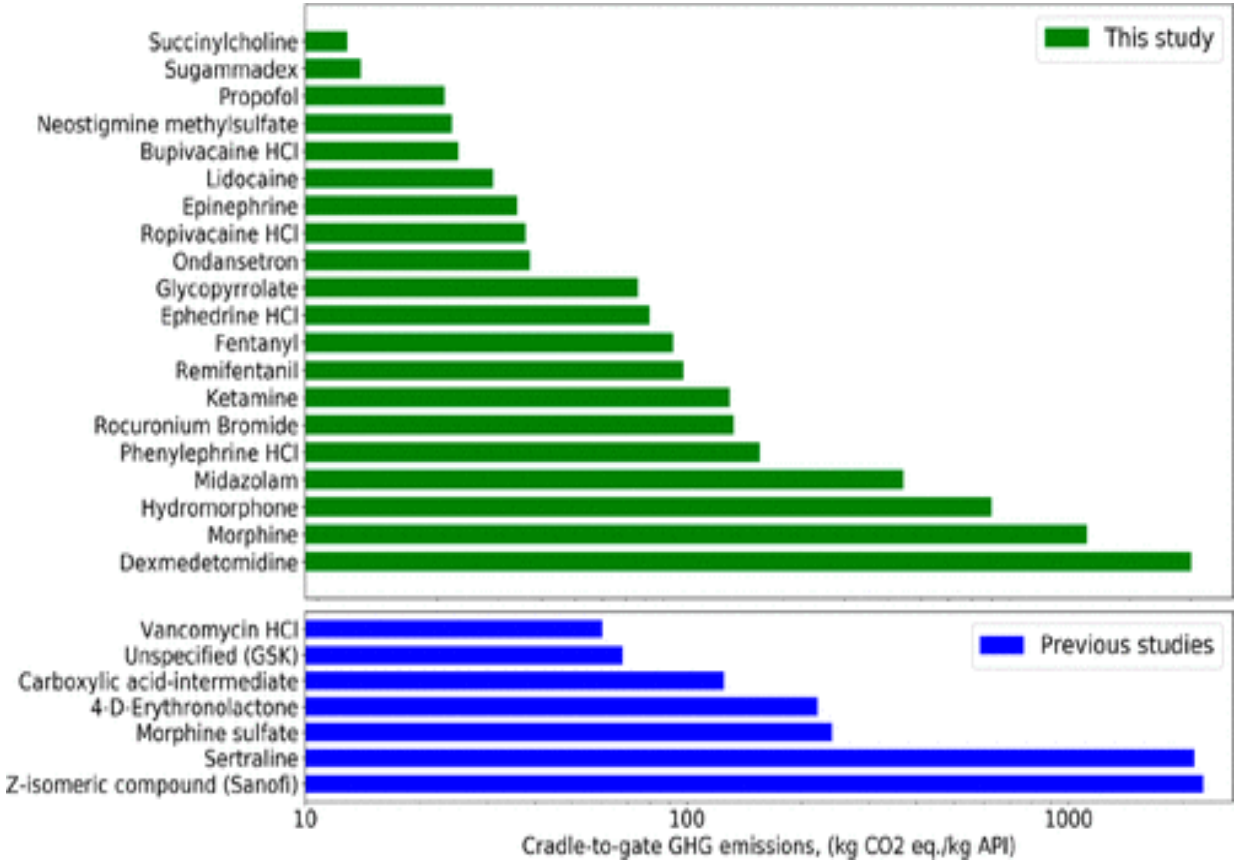
Carbon footprint of pharmaceutical manufacturing

- A cradle-to-gate LCA on production of 20 anaesthetic drugs found:
  - Emissions up to 3000 kg CO2e/kg of drug (compared to 2-15 kg CO2e/kg for many bulk chemicals)
  - Average energy use of 1,600 kWh/kg of drug

In general for pharmaceutical production:

- Synthesis involves many steps
- Yields are low compared to bulk chemicals
- Waste is high

→ Pharmaceutical production is energy- and material-intensive



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Impact of pharmaceuticals

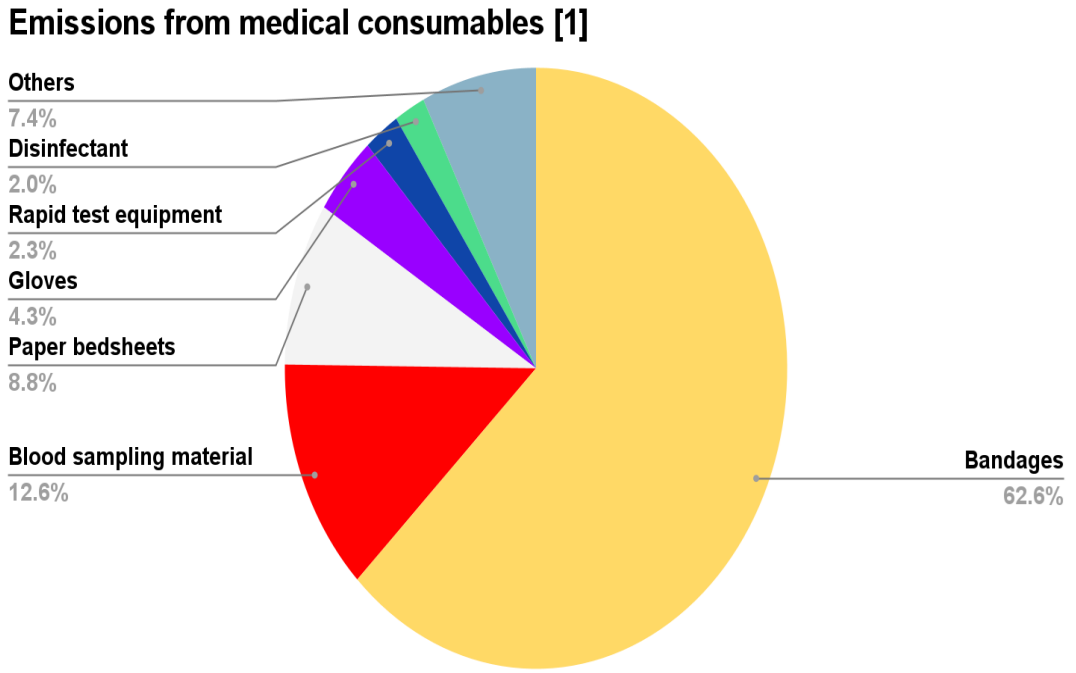
- GHGs from pharmaceutical manufacturing: land-use changes from agriculture, CH4 release from animals whose products are needed for pharmaceuticals
  - Eg gelatin and other animal products needed [1]
- Active pharmaceutical ingredients (APIs) and their metabolites enter aquatic systems after excretion from patients
  - ng/L scale in many bodies of water, chronic exposure has effects on aquatic ecosystems eg endocrine and behavioral changes in fish
  - Situation is worse in developing countries with less wastewater treatment
  - Also effect on land: wastewater sludge containing APIs is used as fertilizer, thereby can enter crops→ animals and humans
- Problem could get worse, as healthcare expenditure increases and aging population using more medicine
- Most sewage systems cannot remove all pharmaceuticals and derivatives [2]
- Especially high concentrations in sewage from healthcare facilities and pharmaceutical factories - up to mg/L [3]

1. Lenzen, M. *et al.* (2020) 'The environmental footprint of Health Care: A Global Assessment', *The Lancet Planetary Health*, 4(7). doi:10.1016/s2542-5196(20)30121-2.
2. Moermond, C.T. *et al.* (2022) 'Greener Pharmaceuticals for more Sustainable Healthcare', *Environmental Science & Technology Letters*, 9(9), pp. 699–705. doi:10.1021/acs.estlett.2c00446.
3. aus der Beek, T. *et al.* (2016) 'Pharmaceuticals in the environment—global occurrences and perspectives', *Environmental Toxicology and Chemistry*, 35(4), pp. 823–835. doi:10.1002/etc.3339.

Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Emissions from consumables in healthcare

- An LCA of healthcare facilities in Switzerland found ~10% of emissions from consumables[1]
- Sources of emissions:
  - Production and packaging
  - Transportation
  - Incineration (usually)
- Barriers to use of reusable equipment:
  - Risk of infection
  - Cost (debatable)



1. Nicolet, J. *et al.* (2022) 'What is the carbon footprint of primary care practices? A retrospective life-cycle analysis in Switzerland', *Environmental Health*, 21(1). doi:10.1186/s12940-021-00814-y.

Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Plastic waste in healthcare

- Medical consumables are often made of plastic
- Plastics account for ~30% of all healthcare waste
- <5% of plastic healthcare waste is recycled in the UK; <10% in the USA[1]

- Mewaldt et al. documented plastic waste generated in an infectious disease unit at a hospital in the USA over 24 hours:
  - Total 168 kg of waste
  - 53% of waste was plastic

→4 kg of plastic waste per patient in 24 hours

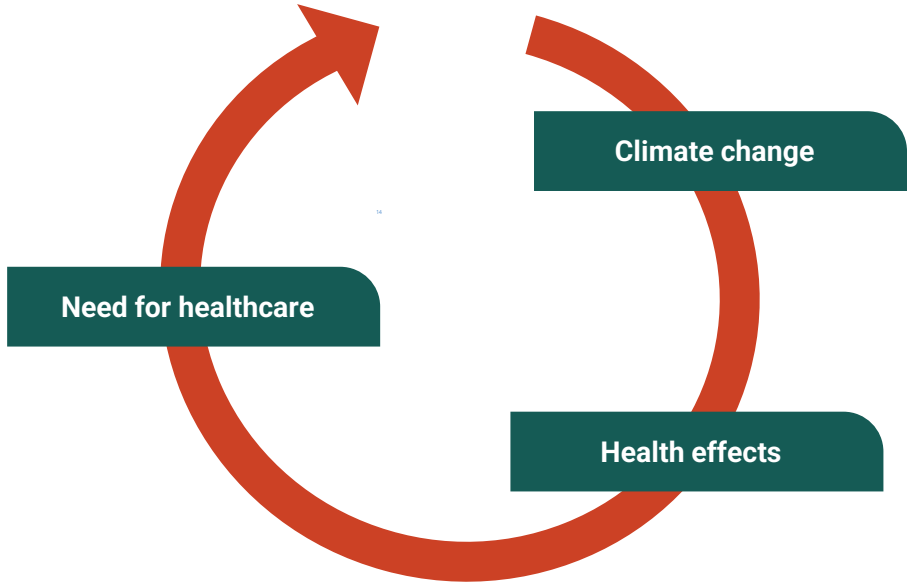
Waste generated in 24 hours in a unit with 20 beds[2]

1. Rizan, C. *et al.* (2020) 'Plastics in healthcare: Time for a re-evaluation', *Journal of the Royal Society of Medicine*, 113(2), pp. 49–53.
2. Mewaldt, C. *et al.* (2023) 'The plastic pandemic: Quantification of waste on an inpatient medicine unit', *The Journal of Climate Change and Health*, 11, p. 100230.

Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Healthcare's role in climate change

- Scope 3 emissions from the whole life cycle of consumables and pharmaceuticals
- Climate impacts of healthcare system can impact human health negatively
- Emissions from healthcare lead to a vicious circle:



Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Other environmental effects of healthcare

- Not only effect on climate change
- Main scope 3 emissions from healthcare are manufacturing and transport of:
  - Pharmaceuticals
  - Disposable/consumable items
- Furthermore, use of pharmaceuticals and disposables in healthcare cause considerable environmental pollution

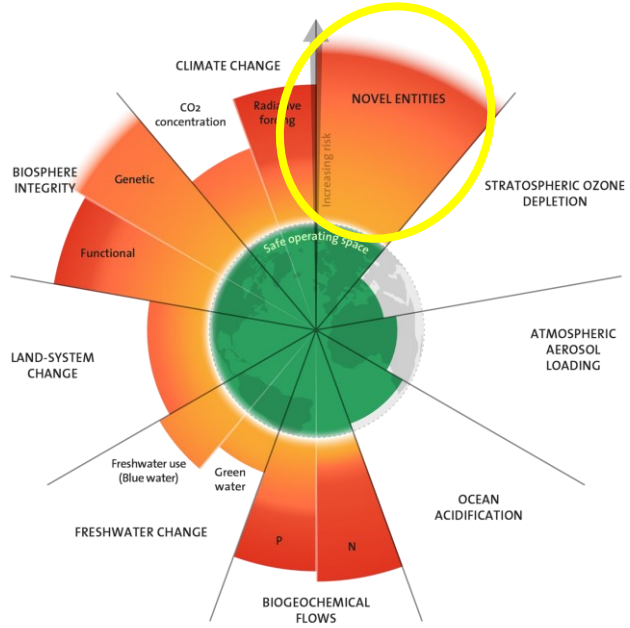


Image: "Azote for Stockholm Resilience Centre, based on analysis in Richardson et al 2023"

Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Working conditions in healthcare

Mental wellbeing of healthcare workers is decreasing

"From 2018 to 2022, health workers reported an increase of 1.2 days of poor mental health during the previous 30 days (from 3.3 days to 4.5 days); the percentage who reported feeling burnout very often (11.6% to 19.0%) increased."

Nigam JA, Barker RM, Cunningham TR, Swanson NG, Chosewood LC. Vital Signs: Health Worker–Perceived Working Conditions and Symptoms of Poor Mental Health — Quality of Worklife Survey, United States, 2018–2022. MMWR Morb Mortal Wkly Rep 2023;72:1197–1205. DOI: http://dx.doi.org/10.15585/mmwr.mm7244e1

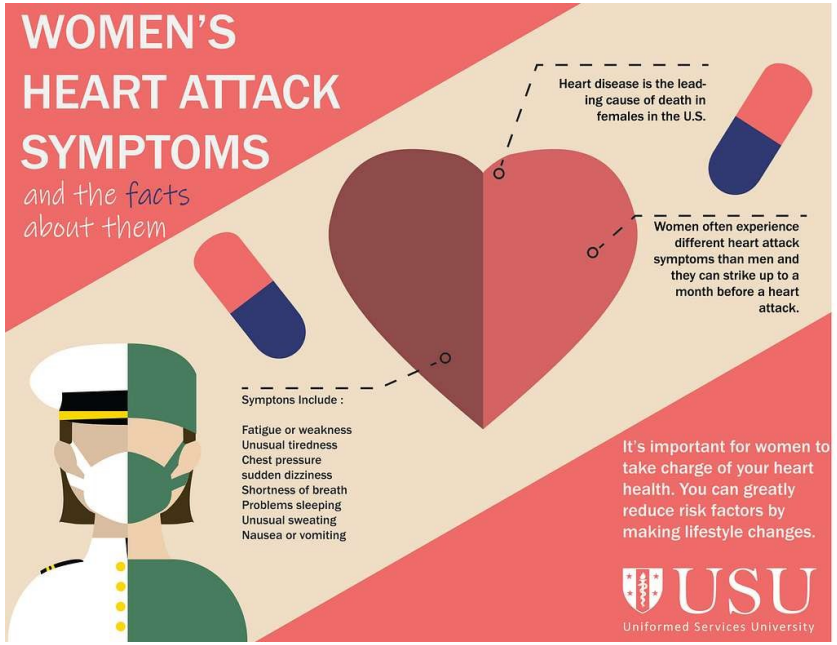
Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Healthcare differences between men and women

Women diseases historically understudied

Cardiovascular diseases in women have different symptoms than men

Women have a higher mortality for cardiovascular diseases and are more likely to be misdiagnosed/not medicated



Al Hamid A, Beckett R, Wilson M, Jalal Z, Cheema E, Al-Jumeily Obe D, Coombs T, Ralebitso-Senior K, Assi S. Gender Bias in Diagnosis, Prevention, and Treatment of Cardiovascular Diseases: A Systematic Review. Cureus. 2024 Feb 15;16(2):e54264. doi: 10.7759/cureus.54264. PMID: 38500942; PMCID: PMC10945154.

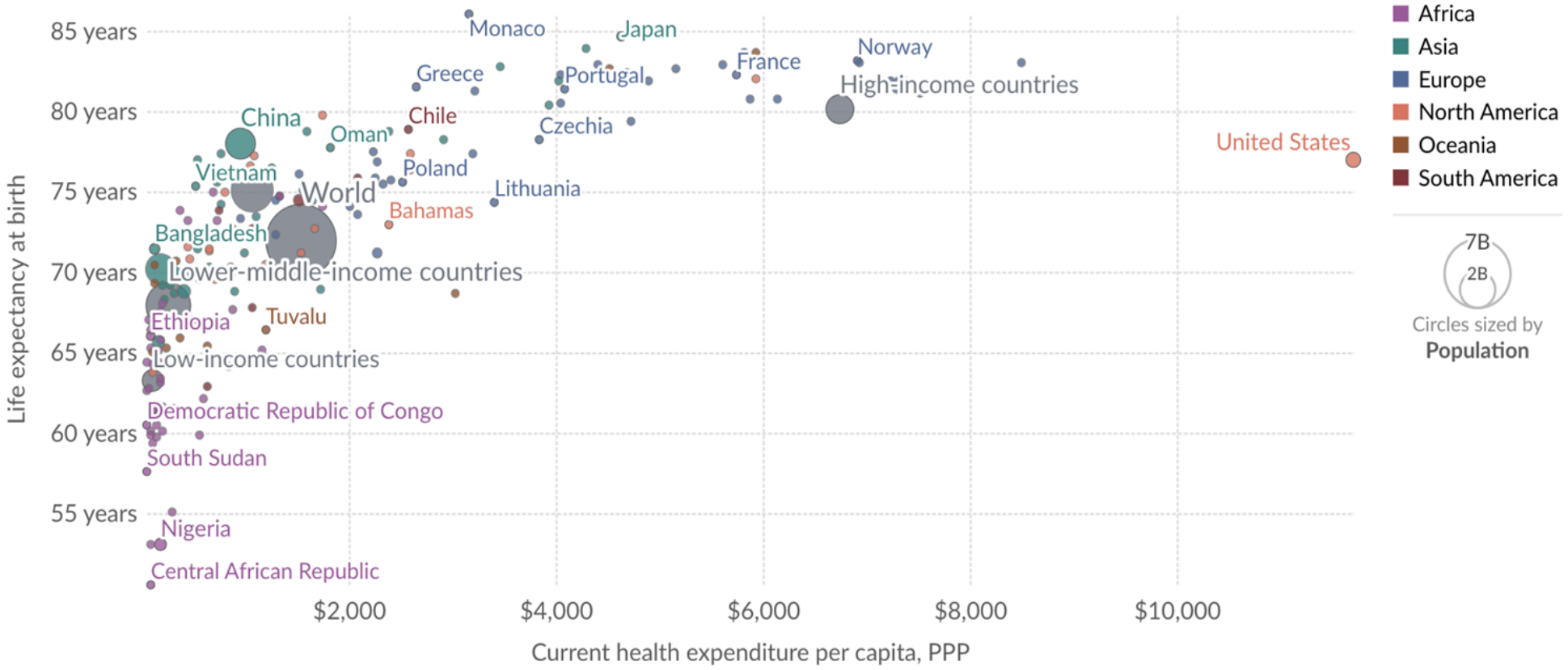
Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Environment | **Social** | Economics

Our World in Data

Health and healthcare funding depends on where you live

At a cross-country level, the strongest predictor of health is national income.

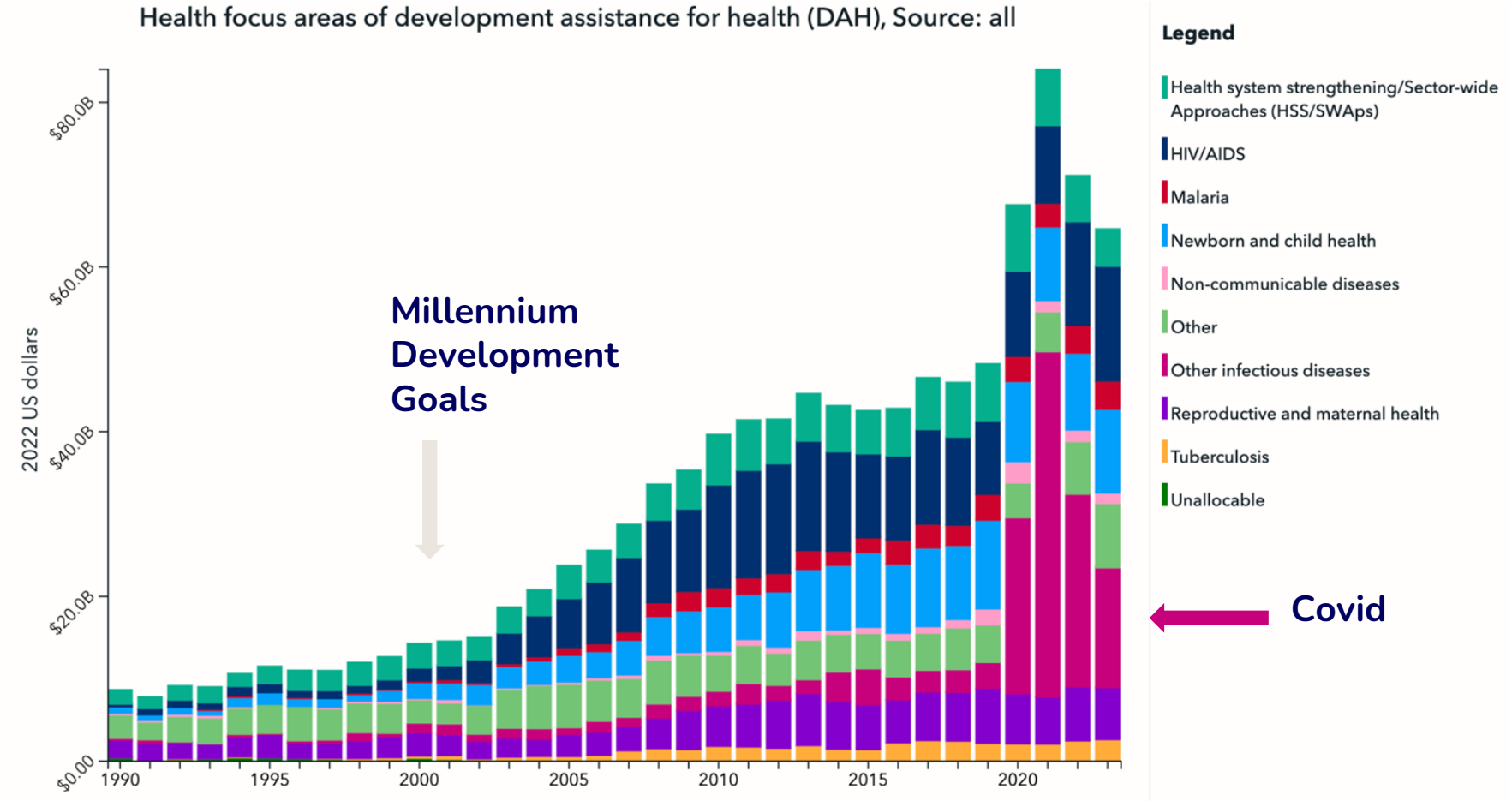


Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

What about developping countries?

How do we prioritized (developping countries)

IHME
Institute for Health Metrics and Evaluation



DAH: Development assistance for health

Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

The amount of healthcare funding for developping countries is stagnant

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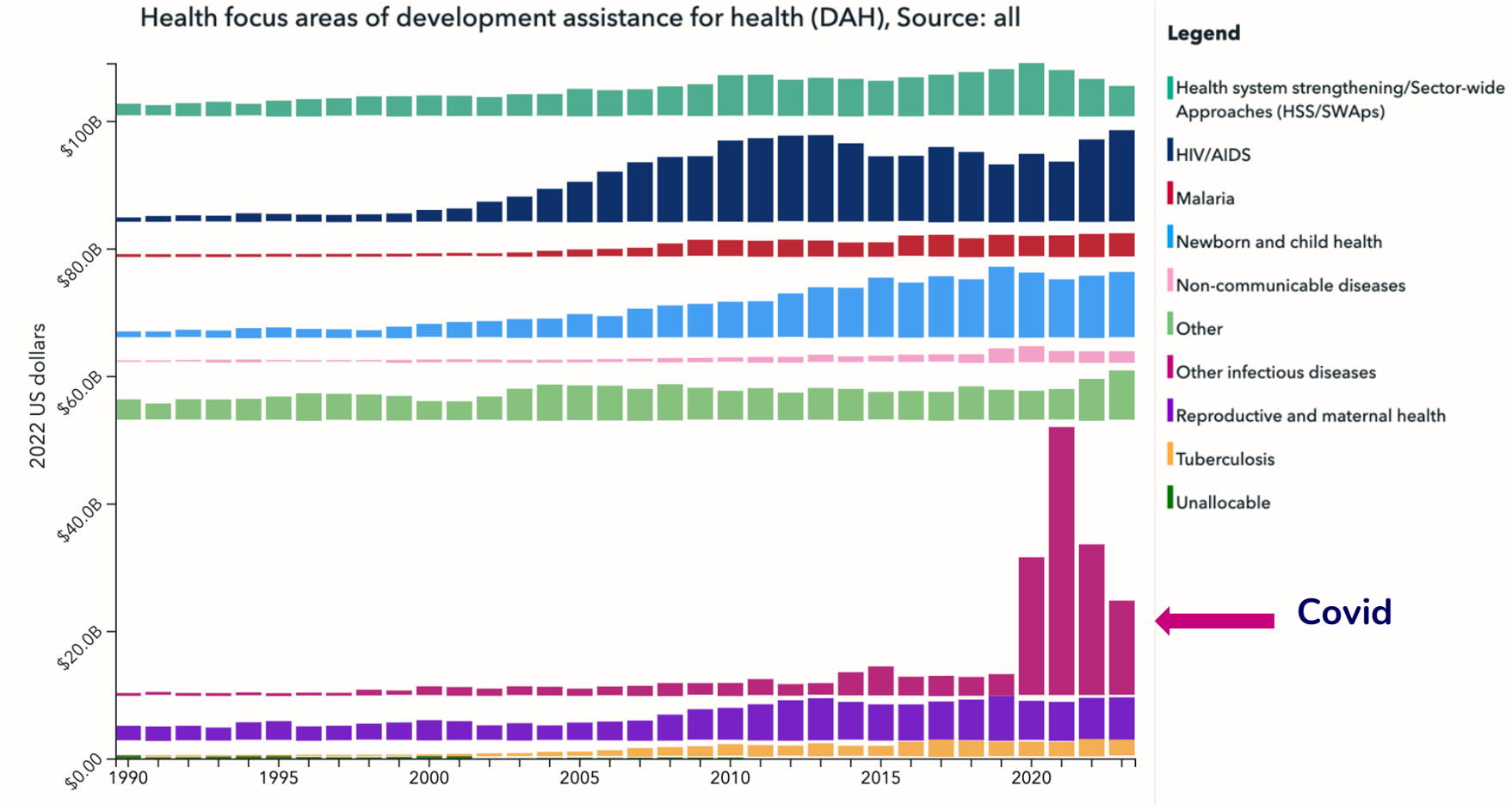

DAH: Development assistance for health

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Funding for developing countries is only 0.2% of global healthcare costs

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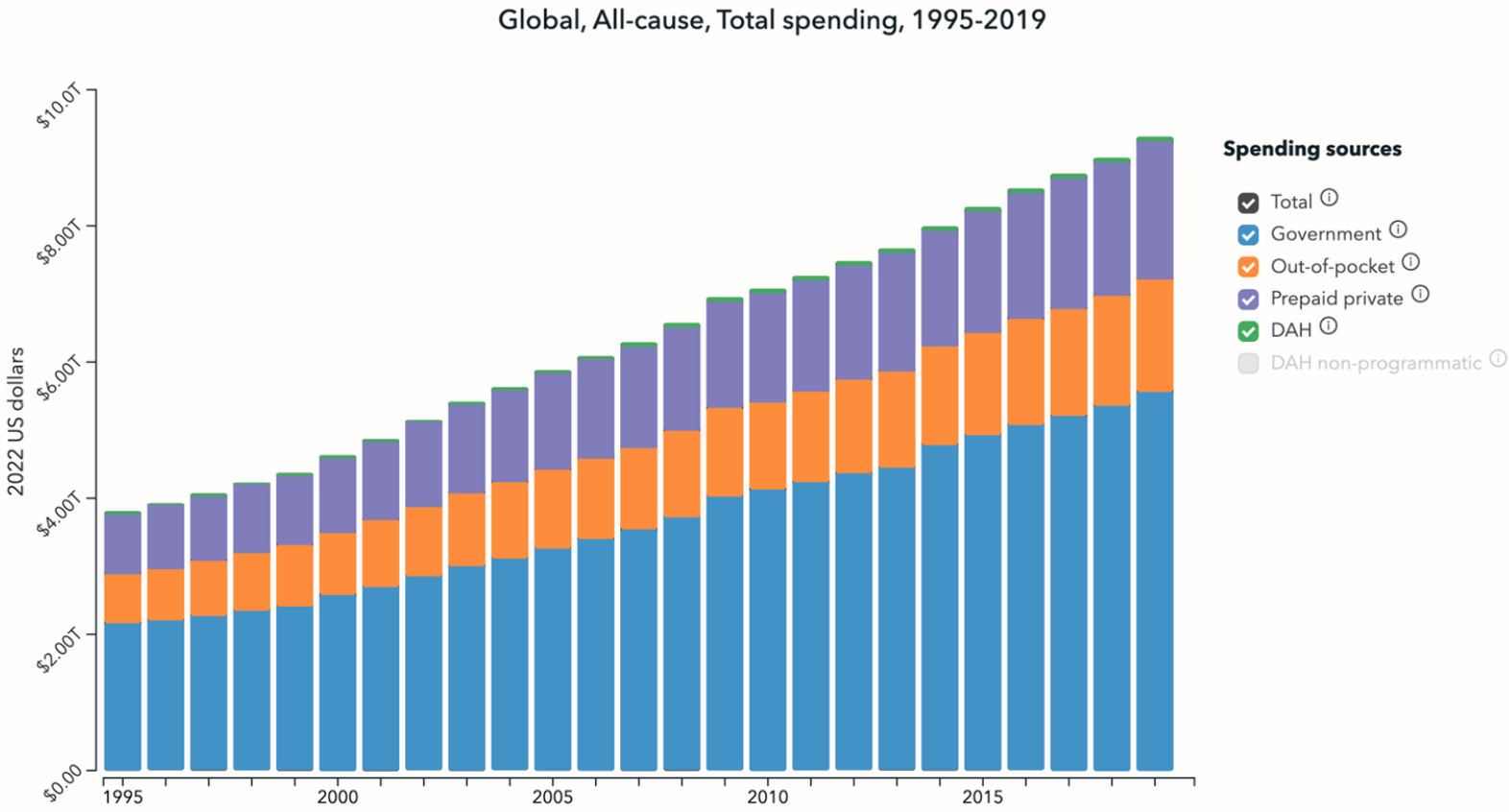

DAH: Development assistance for health

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Moving to sustainable materials?

Challenges with Sustainable Materials

Sourcing: Finding reliable suppliers of sustainable materials

Compliance: Ensuring that eco-friendly materials meet regulatory standards

Cost: Sustainable materials are often more expensive than traditional alternatives

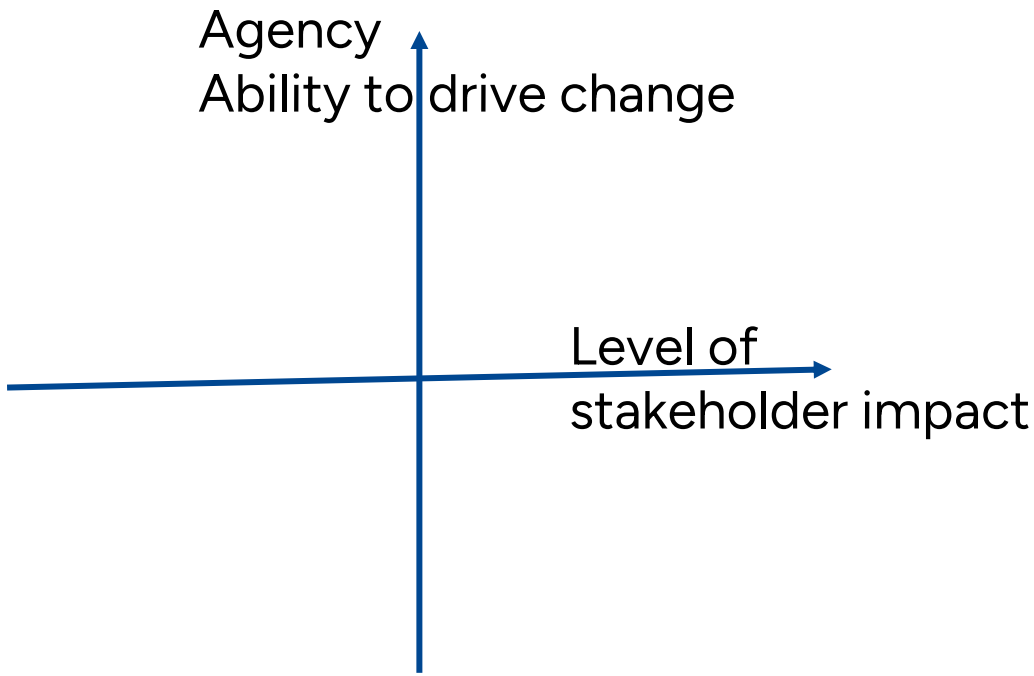
Courtesy: Anna Karlsson, Linnéa Otterheim Leire Alonso Galicia, David Sjönell, Anushka Jantwal

Exercise (10 min)

Pick one question and discuss in group

- How does you PhD project contributes to make heath-care more sustainable
  - Describe using **E S** and **G**
  - Mention for first order and second order effects
  - List the actors with a stakeholder engagement map

- How do you want to contribute at your level?
  - Mention actions to be done at
    - personal level
    - group level
    - Maybe at a future professional level
  - Use the stakeholder engagement map



Summary

- Environment
  - 5% of CO2 emissions
  - Emission-intensive pharmaceutical industry
  - Downsides of single-use materials
- Social
  - Work conditions
  - Equality
  - Global accessibility
- Economical
  - Financing challenges in developing countries
  - Sustainability costs





Thank you for your attention!

Now it is up to you to act … and lets have lunch!